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CRITIQUE

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ON

PROF. TYNDALL'S COURSE OF LECTURES ON LIGHT,

(DELIVERED IN THE CITY OF NEW YORK.)

IN THREE ESSAYS.

BY LOUIS MACKALL, M. D.

WASHINGTON, D. C.
M'GILL & WITHEROW, PRINTERS AND STEREOTYPERS.
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ESSAY I.

TWO SYSTEMS OF SCIENCE.

The European System of Science has recently been presented to the consideration of the scientific mind of America in a very able course of experimental lectures, by the celebrated Professor Tyndall, of the Royal Institution of Great Britain; and this is deemed a fitting occasion to submit to the attention of the public the new and very different system of American Science.

An essential difference between the two systems is hinted in the following sentence from one of the lectures referred to above: "The quarrel of Science with Sir David," (Brewster, who objected to the undulatory theory of light as being too clumsy a contrivance to be referred to the Creator,) "as with many other persons, is that they profess to know too much about the mind of the Creator." Whether to profess to know something of the mind of the Creator, judging from His Work in the Creation, is less pardonable, than to ignore this Mind altogether in scientific views or theories, with Professor Tyndall and with European scientists generally is a question that can be answered more intelligently and more satisfactorily when we get through with these essays.

AMERICAN VIEWS OF SCIENCE.

WHAT IS SCIENCE?—HOW IS SCIENCE ACQUIRED?

Science consists of the generalizations or general propositions arrived at by a proper exercise of the compound faculty of human reason; or, by a due performance of the mental function of reasoning. A plain and succinct account or tracing of this exercise or of this performance of function will be found of the greatest utility in attaining scientific propositions or principles, and in judging of the truth or admissibility of such as have been or may be presented to the mind.

In the acquisition of science, four of the mental faculties are employed consecutively, and in the order now mentioned; namely, the observation, the imagination, the judgment, and the common-sense. In using the latter term, reference is had to a distinct faculty of the mind, by virtue of which it is enabled to acquire "a knowledge of good and evil," as it is quaintly expressed in the Mosaic account of the creation; that is to say, by means of this faculty, when unsophisticated, the mind is rendered capable of deciding as to what is virtuous or vicious, right or wrong in conduct, and as to what is true or false in knowledge or science. This faculty, being common to every sane mind, is here called common-sense.

THE REASONING PROCESS.

This is what usually occurs in scientific reasoning:

1. Some remarkable phenomenon first arrests attention,

and the mind instinctively directs its several means of observation through the senses to this phenomenon.

2. Having in this way noticed the facts or circumstances, the imagination is called upon to furnish a proposition or a scientific principle to explain or account for such facts; and having suggested a proposition for this purpose this stage of the process is completed, the office of the imagination is performed.

3. The mind then calls into exercise the judgment, to decide or to determine if the proposition found by the imagination explains satisfactorily all the facts of the phenomenon presented to the observation. If the proposition is defective or inadequate to this end, it is altered, amended, and fitted to this purpose. This latter performance of the judgment is what should be understood by the term *induction;* that is, the bringing together before the mind all the facts presented to the observation, or that can be gathered from experiments, &c., that they may be collated and compared with the requirements or terms of the general proposition.

4. The crowning act in the process of scientific reasoning, is the final appeal to the mental faculty, that we have designated by the term common-sense, heretofore named the moral sense, conscience, consciousness, &c. That the decisions of this faculty are reliable, we may be assured, by carefully reflecting on or considering the principle on which is founded the institution of jury-trial, and on that involved in the adage: "*vox populi est vox dei;*" for juries and mankind generally are led to the apprehension of truth solely by the dictates of common-sense.

The above plain formula of the reasoning process was traced out by carefully attending to what passed in the

writer's mind in arriving at a general scientific proposition, that will be found, as will be afterwards shown, to be of vast importance and of the highest value to mankind. We will now apply this formula to the notable instance of reasoning of Sir Isaac Newton, in discovering his so-called "Law of Universal Gravitation."

1. As the first step in this course of reasoning, Sir Isaac, it is said, while reclining in his orchard, saw an apple fall to the ground, that happened to arrest his attention. Reflecting on the phenomenon thus presented to his observation, the question occurred to him, "Why should the apple, when detached from the tree, fall or move in this particular direction rather than in any other?"

2. Having been instructed as to the supposed agency of the occult properties of matter, attraction and repulsion, according to the Greek philospher Epicurus, at that time taught in all schools, or, as Professor Tyndall has it, taking a hint from the behavior of iron filings in presence of a magnet, Newton employed his imagination in finding the proposition that *the apple was drawn towards the ground or to the earth by its inherent occult property of attraction.*

3. His judgment was next called into exercise by Sir Isaac, as the third stage of reasoning. By means of this faculty he compared the falling of the apple with the terms of the proposition, and found, as he thought, the phenomenon fully explained: the apple, he imagined, was attracted by the earth, and hence its movement or motion as observed. He then entered upon his induction: the facts or circumstances attending the falling of the apple were carefully attended to; a stone was thrown into the

air and observed to fall to the ground, as did the apple; then letting fall from a height leaden balls and many other ponderable bodies, and observing more accurately the direction they took, he amended his proposition so as to read: "*All ponderable bodies fall or gravitate towards the centre of the earth by virtue of the earth's attraction.*" The motion of ponderable bodies about the earth's surface being thus accounted for, extending the range of induction, he thought the motion of the moon might be explained in the same way: this motion might be effected by the attraction of the earth. Again, observing the motion of the planets about the sun, that had then been demonstrated, varying the centre, he concluded that the motion of all the orbs of our solar system is produced *by the inherent attraction of the sun.* Afterwards, conjecturing from the observed motion of the sun and fixed stars, he again imagined that all the bodies of space revolved around some centre of the universe, being drawn thitherward by the inherent attraction of this centre.

Sir Isaac Newton thus arrived at his Law of Universal Gravitation, that has, since his time, been made to occupy the place in Natural Philosophy that in ancient systems was assigned to the crystalline sphere or envelope of the world, called "the primum mobile." All motion of bodies in nature, whether celestial or terrestrial, is referred to the attraction of gravitation, and the "law," as it is falsely called, or the general proposition resulting from this reasoning is thus stated: "Every particle of matter in the universe attracts every other particle of matter with a force directly proportional to its mass, and decreasing as the square of the distance increases."

It may be observed that a mere general outline of this

course of reasoning is here given, in order to point out its conformity to the formula suggested above; and it may be further noticed, that no attention has been paid to the mathematical processes on which Sir Isaac mainly relied as furnishing the proof or confirmation of his theory of gravitation. This subject has been pretermitted, because the mathematics is nothing more than *the science of equations*, or that department of science that is concerned only with the equation among the objects belonging to other departments of science. It is something (very serviceable indeed in its proper place) growing out of the physical or material sciences; but should never be used, as was done by Newton, as a principal means in the discovery of the principles of these sciences.

This generalization of Sir Isaac Newton was so grand, so much in accordance with the great instinct of humanity, urging the exercise of the reason, that it seems to have carried by storm, as it were, the assent not only of the reasoner, but also that of the scientific mind of the age or period. It has maintained its position as an unquestioned principle of science even down to the present time. Neither Sir Isaac nor any one since his time, with the exception perhaps of the ineffectual attempt of Leibnitz, has ever thought of completing this process of reasoning by an appeal to common-sense. That, on a fair appeal to this mental faculty, the proposition found would have been rejected by himself, may we, think, be inferred from the following sentence in a letter of his to Dr. Bentley, when questioned on the subject of gravity: "That gravity should be innate, inherent, and essential to matter, so that one body may act upon another at a distance through a vacuum, without the mediation of anything else by and

through which their action and force may be conveyed from one another, is to me so great an absurdity, that I believe no man who has in philosophical matters a competent faculty of thinking can ever fall into it.

The above formula of reasoning, when carefully studied and fully understood, enables us to detect the errors in each of the three modes of reasoning that have heretofore been proposed. The syllogism, or the syllogistic method of reasoning, referred alone to the *third stage* of the process stated above, to that in which the judgment is exercised; the other parts or stages of the process were overlooked by Aristotle, in whom this method originated. It was necessary that the proposition should first be found and established, and thus a middle term be provided by the secret and defective mental process, *experience*, before an act of reasoning could be commenced. The induction in this method was very imperfect, and the mind was left to vault, as it were, into conclusions. The Baconian, called also the inductive and the experimental method or mode of reasoning, has reference mainly to the *first stage*, in which the observation is employed; and is made to accumulate and heap up facts or instances derived not only from natural appearances, but also from any number of experiments, serving only, when referred to the judgment in its induction, to fatigue and weary the mind, and thus to unfit it for arriving at any definite conclusion, or for the proper exercise of the common-sense. The Baconian method of reasoning, in which the office of the imagination is vilified, decried, and explicitly rejected, may be said to have destroyed all saliency or natural energy of the scientific mind by which it is embraced. In the Cartesian method, the proposition, in whatever way

it may have been found, is held in doubt until fully established; but how or by what means it is to be *verified*, as the phrase is, is left to conjecture, or to the natural sagacity of the scientific mind, without any specified directions.

Of the above methods the experimental philosophy, which at this time seems to occupy the scientific mind exclusively, is especially deserving of attention, and of being carefully analyzed. Experiments cannot be relied on as furnishing positive proof of the truth of a scientific proposition or principle, for the reasons: 1st, that making experiments is doing nothing more than multiplying instances to be submitted to the judgment in making its inductions; in attending to the results of experiments, other instances more reliable may be neglected; 2d, that experiments are scarcely ever made under precisely the same circumstances with the instance observed in nature; and 3d, that experimenters, as experience teaches, always find exactly what they happen to be looking for, and have very rarely if ever extended the bounds of science by means of their experiments; but have often succeeded in fixing and in stamping, as it were, errors upon the scientific mind as well as on the unscientific. They start out with a certain theory or proposition already framed, and the care or end proposed is to establish this proposition as a principle in science. The office of the experimenter is the same as that of the advocate, to both of whom success in carrying their point is a matter of higher consideration than is the triumph of truth or justice. This view of the subject is illustrated and its correctness fully confirmed, as will be afterwards shown, by a reference to the course of experimental lectures recently delivered amongst us by Professor Tyndall.

Using our own method of reasoning, presented above,

we have arrived at the following propositions, that are offered as fundamental principles of the science of matter, or of material science:

1. Matter, in itself, is absolutely inert, powerless, devoid of any capability of action, and has never been endowed with any active property.

2. All motions and changes of form, that embrace all the appearances of action in matter, are effected by influences extraneous to matter; that is, by a certain class of the laws of nature, fourteen in number, that may be designated by the term *physical laws*. These laws of nature, ordained by "the mind of the Creator," are the sole secondary or proximate causes of such motions and changes of form.

3. Force or power is attached to or connected with no form of matter; but physical force, or the power in nature, is simply a provision for the execution of the aforesaid physical laws, and is only exhibited in nature when some one or more of these laws are being executed.

The above principles of material science are proclaimed by, or may be learned from, every part of the economy of nature; and when fully considered, must be accepted as truths by the common-sense of mankind.

Sir Isaac Newton knew nothing of these scientific principles, or he never would have constructed his theory of Universal Gravitation. Take away from this theory the grave error of regarding matter as being endowed with the active occult properties of attraction and repulsion, and this immense mental fabric totters to its rotten base, and falls to the ground. The phenomena referred to this principle of gravitation are much more rationally explained by means of another theory.

Professor Tyndall, when he determined to cross the ocean to lecture, as he evidently thought, before a very ignorant and wholly unscientific audience, had no knowledge of these principles, or he would never have been driven to the common resort of the Materialist and of the Atheist, that of investing Nature, personified as a female Divinity, with the whole work of creation. Any allusion to "the mind of the Creator" was offensive to him; but he everywhere dwells, seemingly with much complacency, on the agency in natural phenomena of this feminine Deity. "If we were permitted," says he, "to inquire into the intention of *nature**" . . . "If what are called material purposes were the sole end of *nature*" . . . . "Would it not seem that *nature* had harbored the intention" . . . . "whatever *nature* meant" . . . . "what *she* meant." Again, he says, "In the process of crystallization *nature* first reveals *herself* as a builder." Where do *her* operations stop? "Does *she* continue by the play of the same forces to form the vegetable and afterwards the animal?" "Whatever the answer to these questions may be, trust me, that the notions of the coming generations regarding this mysterious thing, which some have called 'brute matter,' will be very different from those of the generations past." It is earnestly to be hoped that these notions will be changed, but not, we trust, in the direction clearly indicated by the lecturer.

Professor Tyndall's views regarding molecular and other forces, and that relating to crystallization, are extremely crude and unphilosophical, and are undeserving of a place in any scientific mind. The proposed limit to this essay will not permit us to point out in detail the

* The *italics* are ours.

particular errors involved in these views; but some notion of our meaning here may be gathered from that we take of what occurs in a game of billiards, to which he refers, and to which we now call attention.

THEORY OF A GAME OF BILLIARDS.

The motion of the billiard-ball is not derived from the matter concerned in this game—it proceeds not from the impulse of the cue, or from the elastic property either of the sides of the table or of the ivory ball; but the motion of which we are speaking is caused solely by certain *physical laws*. The motion of the ball throughout its course is due, mainly, to the Law of Muscular Action, one of the physical laws that the player brings into operation by providing the necessary conditions, that is, by determining his nerve-fluid to and from the muscles engaged in the blow—by this means contracting some and actively elongating others of these muscles. In causing this motion, the force of the aforesaid law is however assisted, to some extent, by that of the physical Law of Elasticity that is also brought into play, or into operation, by the forcible compression of the elastic sides of the table and of the ball.

The force with which the ball moves, or the force here exhibited, is from the two physical laws mentioned, and is proportional to the quantity of matter influenced by these laws—that is, to the size of the ball, the strength of, or quantity of nerve-fluid determined by, the player, and to the extent of the compression and reaction of the elastic bodies named.

The velocity of the ball is inversely as the resistance encountered in its course from the force of some other physical law or laws, that may be there in operation.

The force of the Law of Cohesion, that might resist the motion of the ball, would be less, and the velocity of the ball greatest, in a rarefied medium, than in air, in water, and so on; the velocity becoming less as the medium becomes denser.

Pondering and carefully studying the short lesson in natural philosophy just given, it will be observed that we have separated entirely all action from matter. The apparent action of the ball consisting in its motion, that of the muscles apparently in the contraction and active elongation of their fibres, and that seemingly from elastic bodies in the reaction or restoration of their molecules to their normal condition, are all taken away from the matter—dissociated from it in the mind, and are referred to physical laws as their true sources or causes.

Force, too, is here dissociated entirely from matter, and associated with the operation of these physical laws, wherein alone it is exhibited in nature.

Having learned these vastly important truths, the fallacies, erroneous conclusions, and false philosophy generally, contained in Professor Tyndall's course of lectures on Light, will very plainly appear. Matter, or the molecules of matter, are utterly devoid, as we have said, of any capability of action; and when we enter upon the investigation of nature, it becomes us first to learn the *laws* that have been decreed by its Author for the government of the economy of nature.

In our next essay it is proposed to communicate something about Light, its nature, generation, propagation, and its uses, or the useful purposes to which it is applied in nature, that seems never to have been dreamed of in Professor Tyndall's philosophy.

ESSAY II.

MATERIAL SCIENCE.

TWO PRINCIPAL FORMS OF MATTER.

Matter, or the forms of matter, are separated in nature into two grand divisions—that is, into ponderable and imponderable or diffusible bodies or forms: one of these divisions being governed by, or being subject to, the physical law of Gravitation, and the other division to the law of Diffusion.

PONDERABLE BODIES.

Ponderable bodies, by virtue of the law of gravitation, are compelled to move towards the centre of the earth, do constantly tend to move in this particular direction, and do invariably so move, unless the force of the law of gravitation is counteracted or overcome by that of some other physical law or laws with which it comes into collision. A leaden ball falls from an elevated position to the ground in the direction from that position to the centre of the earth; but at the surface of the ground the force of the law of Gravitation, by which it was moved, is overcome by the superior force of the law of Cohesion, acting on the body of the earth, and the motion of the ball is suspended.

IMPONDERABLE BODIES.

Imponderable forms of matter, by virtue of the physical law of Diffusion, are made to move towards other surround-

ing bodies in all directions, that they may be merged or enter as constituents into such bodies; and they are so diffused, unless confined by the force of cohesion acting on the substances, as glass, &c., by which they are confined or enclosed. The imponderable forms of matter are: life, light, heat, steam, aqueous vapor, volatile effluvia, electricity, sound, odors, and the gases.

THE ATMOSPHERE.

It will be found convenient in material science to regard the atmosphere as a third division of matter, occupying a neutral position between ponderable and imponderable forms; and serving as the arena on which are exhibited the motions of the two principal divisions mentioned. For, although the air of the atmosphere is confessedly a ponderable form of matter, its tendency to gravitate towards the earth is so constantly counteracted by means of the physical law of Suction, as will afterwards be explained, that it may fairly be regarded, in the light named above, as being a neutral form of matter.

WHAT IS LIGHT?

If the scientific propositions stated above be true, and they are the results of legitimate reasoning and are clearly in accordance with the dictates of common-sense, then light is emphatically *a form of matter*. The same course of reasoning that would make light and heat modes of motion, would also show that gold and other metals are merely *modes of motion;* for motion necessarily attends their extraction from their native ores, as it accompanies the liberation of heat and light by friction from bodies in which they had become latent.

PROPAGATION OF LIGHT.

Light is propagated or diffused by means of the physical law of Diffusion as its cause of motion, to which, as we have seen, all imponderable bodies or forms in nature are subject. Light is not propagated or emitted by luminous bodies at all, not even by the sun; for this would be in contravention of that which, we have said, is a fundamental principle of material science; it would be attributing action to inert matter, when this action may plainly be referred to a law of nature, that was ordained in the beginning of the world for this special purpose by the mind of the Creator. The propagation of light has for its true secondary cause the physical law of Diffusion.

GENERATION OF LIGHT.

We come now to the problem of *the generation of light*, and in demonstrating this problem, as mathematicians say, it will be necessary, first, to trace out a law of nature, a physical law that may be called the law of Decomposition, or the law of the Life-current; for it is by means of this law that all decompositions of material bodies are effected. By virtue or authority of this physical law, employed in nature as a secondary cause in effecting the changes of form of matter, material bodies or forms are decomposed in this way: A current of any material being started, and passing by or near to any other compound body, the life of such body is made to pass along with this current; the compound natural body being thus deprived of its most essential constituent—its life, its other constituents are absolved, set free, thrown into pi, as printers have it, and may then appear in their original

forms, as radiant heat, light, &c. Striking instances of the operation of this physical law are witnessed in a stroke of lightning, in combustion, in tornadoes, in freshets, in the use of the compound blow-pipe, and in that of the galvanic battery. Less striking, and therefore less noticed, instances of this operation may be observed in every part of the economy of nature, or wherever changes of form of matter are effected.

Light being an imponderable form of matter, and being diffused, as we have seen, in order to be merged into, or to become constituents of all surrounding bodies, is set free in these decompositions, and is exhibited in its original form of radiant light; hence the light exhibited in the use of the galvanic battery, and called *the electric light*. Rays of light are currents of light, instituted by means of the law of diffusion, and the force accompanying the operation of this physical law being, like that of all other physical laws, proportional to the quantity of matter influenced at the time by the law, the force of the electric light may be largely increased.

The failure in the first Atlantic cable was most probably owing to the decomposition of the wires by means of the too strong currents of electricity passing through them at that time; and it is no wonder that an audience should have been constrained to turn away their eyes from this electric light, then largely increased by the quantity of electricity, and consequent force of the currents there generated. The vivid impressions from the direct rays from this source were sufficient, if continued, to decompose the optic nerves subjected to them.

OF COLORS.

Colors are the constituents of light, a ray of sunlight being divisible into more simple rays of seven different colors by means of a prism, that are hence called prismatic colors, such as are seen in a rainbow. These colors are named respectively, red, orange, yellow, green, blue, indigo, and violet. When light is diffused, as we have seen, to bodies of matter, the rays of some one or of all of these colors combine with, or become constituents of, such bodies, and communicate to them their particular color; and so we have bodies of various colors in nature. Why bodies should thus be combined with rays of certain colors, and how this result is attained, are questions that are sufficiently answered in saying, that such is the appointment of the Creator. These are to the human mind ultimate facts of the same nature with those of the gravitation of certain bodies and the diffusion of others. To attempt to explain the phenomena by referring to the "*sifting*" and "*selection*" of rays by the molecules of matter, is merely talking at random, and without reasoning; there is no capability of sifting and no intelligence for selecting in these inert and senseless molecules. The reflected rays from a colored body serve not to form the ideas of such bodies that are presented and received into the mind. These ideas, as will be afterwards shown, are made up from the *radiant life* proceeding from these bodies: the colored rays of light being but a small proportion of their constituents. The ideas formed in the mind by the aid of colors are sometimes very pleasing, and hence we hear of "the luxury of colors."

THE USES OF LIGHT IN NATURE.

The most useful purposes to which light is applied in the economy of nature are not those of its propagation or *emission*, as is said, nor of its reflection and refraction; although these are most dwelt on in public lectures, because capable of making vivid impressions, and of producing brilliant ideas. Its other uses are vastly superior to these, and deserving of a much higher estimate.

When the Creator said "let there be light," he placed in our solar system a body, the sun, in which light is constantly being generated, and from which light is diffused incessantly to surrounding bodies. At the same time he ordained laws to govern or to regulate the acts or conduct of all living creatures; these true laws of nature are—the instincts. It has long been observed or inferred that the growth and perhaps other acts of living creatures are in some way influenced by their environment; but how, or in what manner, has not been explained. It has, however, been recently discovered by plain reasoning, that this environment, or the bodies surrounding beings in nature, are appointed by divine wisdom to suggest to living creatures obedience to their instincts, obedience to the laws made to govern their conduct in this state of being. Articles of food, with which it may be surrounded, are made to suggest to the hungry animal obedience to the instinct that prompts it to take its food; the warm moisture, or the moist warmth of Spring suggests to vegetables the germination of seeds and the further growth of plants. Impressions so made may be called *suggestive impressions*.

Now, the sun, in the divine government of our world,

is made the source of the great suggestive impression in nature. Sunlight suggests obedience to a large number of instincts, not only of the animal, but also of the vegetable kingdom. Many of the effects from this inert form of matter, now attributed to the direct agency of the sun, are, in truth, but the results of this appointment by an all-wise Creator. The sun has in fact no agency in nature, being in itself, like all other forms of matter, absolutely inert or devoid of action; but its beams are made by divine wisdom suggestive impressions, that serve to suggest actions throughout animated nature. We shall return to this subject after awhile, in order to show in what manner and by what means these laws of nature—the instincts—are executed.

PROFESSOR TYNDALL'S MATERIAL SCIENCE.

We will now go back and see how Professor Tyndall views this subject of the science of matter. Our "quarrel" with this celebrated Professor, and with scientists generally, is that they have never investigated, searched for, the true laws of nature: the laws referred to by them being nothing more than the generalizations or the general propositions resulting from the exercise of human reason. They are but the principles, such as they are, or the *rules* of science. Scientists have not the slightest conception of a law of nature as decreed by the Author of nature: no more definite idea or notion of such an agency in physical phenomena than a person born blind has of colors.

As a natural consequence of this ignorance, they have no rational conception of the subject of causality, of causation, nor of the actual secondary causes in these phenom-

ena; and consequently are astonished at the wonderful force exhibited by atoms and molecules, and are awe-struck on witnessing the energetic movement of these molecules, as in crystallization. "The Professor himself declared he never witnessed this" (crystallization) "without a feeling of awe at the enormous display of energy on the part of atoms which singly must ever remain invisible." Had he been acquainted with the physical law of Crystallization, he would have known that these invisible atoms had no active agency in the phenomenon, and in themselves were possessed of no energy whatever. He would then have known that the cause of motion in such instances is the physical law referred to, that the force or energy exhibited was derived from the operation of this law, and was of the same character with, and no more to be wondered at than, the falling of a stone from the air into which it had been thrown, or of an apple from its tree. To Professor Tyndall it must indeed have been a matter of great wonderment to see "*molecule close with molecule*," and "*throw themselves in preference on the crystals already formed.*" But after dwelling on the antics of molecules in the phenomenon of crystallization, he goes on to add:

"Throughout the process you notice one feature which is perfectly unalterable, and that is angular magnitude. The spiculæ branch from the trunk, and from these branches others shoot; but the angles enclosed by the spiculæ are unalterable. In like manner you may find alum-crystals, quartz-crystals, and all other crystals distorted in shape. They are thus far at the mercy of the accidents of crystallization; but in one particular they assert their superiority over all such accidents—angular magnitude is always rigidly preserved."

Now, it seems strange to us that this very remarkable fact or feature, so plainly observed and so attentively noticed, did not serve to stagger the learned Professor's Materialism, or the attributing action to matter. This remarkable conformation and peculiar arrangement of crystals implies not only active agency and great energy, but also a high degree of intelligence. To attribute all these to dead, senseless, and insensate matter, appears to us to be an utter perversion of reason, an overslaugh of common-sense by mere authority.

In our next essay we will briefly refer to the Science of Mind, and will then take occasion cursorily to look into Professor Tyndall's Metaphysics.

ESSAY III.

THE SCIENCE OF MIND, OR METAPHYSICS.

The progress of the scientific mind from facts to principles was explained and fully traced out in our first number.

All ponderable bodies about the surface of the earth tend to move towards the centre of the earth, is a scientific principle; *the proximate cause of this motion of ponderable bodies is the physical law of gravitation*, is a higher or more valuable principle of science; *physical force, or the power in nature, is immediately derived from the operation of some one or more of the class of physical laws*, is a still more valuable principle of material science; but *the apprehension of a law of nature, when in operation in the economy of nature*, is the most valuable acquisition of the human mind, and its attainment requires the highest reach of the intellect. With the knowledge of the laws of nature thus obtained, the mind fairly realizes the all-important truth, that to the Creator belong the Kingdom, that is, the government of the natural world by means of His laws; the Power, appointed for the execution of the physical laws; and the Glory, or credit, of having formed in His will the vast design or plan of the Creation.

In this wise plan physical force is seen to be a provision for the execution of the physical laws that are here made to govern the motion and changes of form of matter; and in this divine plan enjoyment and suffering are the pro-

vision made for the execution of the laws that are designed to govern the acts or conduct of living creatures—the instincts. These latter require the due performance of all the functions of creatures, and the proper exercise of every faculty with which they are endowed—the pleasure or enjoyment of creatures being commensurate with the exactness with which these requirements are met, or with the fidelity with which the instincts are observed or obeyed. The exercise of the reason in arriving at scientific propositions is a source of high enjoyment to the scientist.

PROFESSOR TYNDALL'S METAPHYSICS.

We pity the Materialist who, in attempting to explain physical phenomena or natural appearances, ignores the mind of the Creator and his laws—the true laws of nature, and looks alone to the inert, senseless molecules of matter as the active agencies or *causes* in these phenomena. This is, as it were, a rehearsal of Shakespeare's play of "Hamlet" with the character of Hamlet left out; it is as if the grotesque movements of what are called Cartesian devils were exhibited before a popular audience, without any explanation of the means by which these movements are effected.

Physical theories, which, in the sense commonly used, is but another term for materialism, are our utter detestation; as they serve to mislead the mind away from the contemplation of the all-wise providence of God, displayed in his creation. Sir Isaac Newton's theory of Universal Gravitation, according to Professor Tyndall, is a physical theory. "If it were so, it was a grievous fault, and grievously has Sir Isaac answered it." An humble and a devout Christian as he was, it must to have grieved him

sorely to find Atheists making use of this theory as a principal support of their foolish doctrines.

The physical theory of atmospheric pressure is as false as that of universal gravitation, which latter may be substituted by the physical law of Interchange of life. We beg leave to be allowed to say that atmospheric pressure is but a myth, a mere fantasy, that has been seized on by the mathematicians, and by means of their equations and calculations, made to be a pressure of fifteen pounds to every square inch of surface on a level with the sea, or, which is the same thing, at the spherical outline of the earth. One of the physical laws, which, as we have said, are a class or code of the laws of nature, is the law of Suction, that may be thus expressed: *Let adjacent bodies, according to their mobility, move or press towards a vacuum, or rarefied space.* Instances of the operation of this physical law are seen in the barometer, wherein a column of mercury of thirty inches is sustained in the tube by means of this law, that is, brought into operation by means of the Torricellian vacuum at the top of the tube; in the Madgeburg cups or hemispheres, a vacuum being established within, and their substance or sides thus made to press towards this vacuum, &c. Now, there is a rarefied space all around the outer circumference of the atmosphere, ending in a perfect vacuum in the regions of space, and towards this vacuum the air is compelled to press, by virtue of this physical law of Suction. The atmosphere is thus kept suspended between this rarefied space and the surface of the earth, as a stage-curtain is kept suspended between the ceiling and the floor by means of cords and pullies attached to the ceiling. The air is not allowed to be lifted from the earth, because of the law of gravita-

tion, the force of which, antagonizing that of the law of Suction, the atmosphere is thereby kept in its place. The same antagonism between these two physical laws is observable in the barometer and in the water-pump. There is then no pressure on the surfaces immersed in the atmosphere—the phenomena heretofore referred to atmospheric pressure being much more rationally explained by reference to the physical law of Suction.

The physical theory, called the emission theory of light, is utterly false, not because it does not meet the requirements of the undulatory theory; but because, in this theory, action is attributed to bodies or molecules of matter—to luminous bodies, *by which it is said to be emitted*, when the motion of light, as that of all imponderable forms, is referable to the physical law of Diffusion, as its sole proximate cause. And now we come to the consideration of Professor Tyndall's pet physical theory,

THE UNDULATORY THEORY OF LIGHT.

In teaching this theory, the Professor happily alluded to its demonstration as an up-hill business. To our mind his strength failed him—he gave out, as we say—before he had climbed half way up this hill.

Notwithstanding his earnest desire that his audience should "realize with the utmost possible clearness the propagation of waves," he seemed unmindful of the adage: "Scire bene, est per causas scire;" for he entered not upon the consideration of the cause of waves or the cause of their motion. In the absence of instruction on these points, let us suggest:

A cause of motion both of air and of water is the phys-

ical law formerly spoken of—the law of Suction. When a limited space in the atmosphere becomes rarefied from any cause, an adjacent portion of air is compelled, by means of the law of Suction that is now brought into operation, to press towards this rarefied space; at the point from which the second portion moves, a vacuum is momentarily established, and into this second vacuum a third portion of atmospheric air is made to press; and so on in a long series both of rarefied spaces and of the motions of limited bodies of air, constituting waves of air. The same thing occurs in the use of a siphon: a portion of the liquid in the long arm of the tube is made to move forward by suction, or otherwise, and into the vacuum thus formed another portion is compelled to press, and so on until the supply of liquid to be drawn off is exhausted.

When winds or the motions of the air take place over water, as on the surface of the sea or ocean, it will readily be understood how both the air and water will be influenced by this physical law of Suction—the air being more mobile, will be most influenced; but the water will also be affected by this law. When a vacuum occurs in the air at the surface of the water, a portion of water will be raised from its level towards this vacuum, to an extent proportional to the force of the law of Suction; and when this force ceases, that is, when the vacuum is filled either by air or water, the latter being a ponderable body, and the law of gravitation coming into operation and its force preponderating over that of the law of suction, the water that was raised towards the vacuum now sinks towards the centre of the earth, being carried up and down by means of the two antagonizing physical laws of suction and of gravitation. We now have a clear conception of

the waves both of air and of water, and are enabled to understand the actual motion of both as observed in nature. The motion of the air will be more extensive and more rapid than that of the water; but there is a motion, though slower, of the waves of the latter in the direction of the former, unless this motion is impeded, suspended, or reversed by means of some other force accompanying the tides, &c. We return now to the consideration of the Undulatory Theory of Light.

The luminous ether that in the theory is made to fill all space, appears to us, as it did to Sir David Brewster, "too clumsy a contrivance to be referred to the Creator;" it is too awkward an arrangement to be admitted as a part of the plan of creation; it seems rather a human device. We now know how light is transmitted, even through space, as we have the physical law of diffusion as the efficient proximate cause of this motion, that serves to explain all the phenomena, without even the supposition of the elasticity of particles of light. The force with which light moves is proportional to the quantity of light influenced by this physical law at the time of its diffusion; and the velocity of motion is inversely as the resistance encountered in its progress from some other physical law or laws. The sun is the unfailing source of an immense quantity of light, and the force of its emanations is proportional to this quantity; its beams, being unimpeded in their progress through the regions of space, move with astonishing velocity.

The medium of luminous ether, imagined by Dr. Young, and so strenuously advocated by Professor Tyndall, is an entirely gratuitous supposition, wholly uncalled-for and of no conceivable use in the economy of nature. Before

it could be admitted into any rational system of science it will be incumbent on Professor Tyndall or its advocates to find out a new code of the laws of nature; since the medium supposed could not be amenable to any such laws that have yet been discovered.

Before closing this last of our series of very imperfect essays, we must do Professor Tyndall the justice to say, that in coming among us to deliver his course of lectures on Light, although abounding, as we have seen, in baneful errors, yet we sincerely believe he acted from the purest motives, and with the fullest conviction that he was thereby promoting the advancement of true science, and was furthering the cause of truth.

It was a fancy of Lord Bacon, to name the errors by which the human mind is most apt to be deceived "idols," and he classified these errors as "the idols of the cave," "idols of the forum or market place," &c. Professor Tyndall has, for several years, ensconced himself in the Royal Institution of Great Britain in London, and in this his cave has made numerous very curious, very ingenious, and elegant experiments; with some of which he has recently astonished and delighted our people. By these, as we have before intimated usually happens in making experiments in natural philosophy, he has rather stamped firmly, riveted, as it were, on the scientific mind, errors that had previously been held in some doubt, than advanced any new truth of importance. He has, when so occupied in his cave, watched with lynx-eyed keenness of vision every phase, down to the evanescent tints of a soap-bubble, to see, and listened with the exquisite hearing of the Chiromys to hear, the weak, feeble voice of nature telling him of her secret paths—paths that could not be seen,

and a voice that could not be heard by ordinary mortals. From this cave, assisted by his imagination, he has penetrated into the innermost recesses of nature, "into the subsensible world," by "visualizing the invisible," and there observed, with the same keenness of perception, until he was enabled faithfully to describe the curious movements or antics of the atoms or molecules of matter—these energetic, pugnacious, smart, and intelligent little creatures "which, singly, must ever remain invisible."

This world-renowned "Investigator of Nature," as the Professor is pleased to regard himself, *has, however, never thought of coming up out of his cave, into the great world as it was made by the Creator; has never looked into the economy of nature as it was planned by its Author, in order to learn what was going on* THERE.

APPENDIX.

In the peroration to his lectures on light, Prof. Tyndall, under shelter of the authority of De Tocqueville, has cast unmerited reproach on the people of the United States. His charge in this censure not only expresses a doubt of the ability of our form of government to foster the labors of scientific research, but explicitly alleges that all our intellectual treasures are derived from our ancestral home—Great Britain. Our great invention of the Electric Telegraph, which has been copied and made use of in every civilized community on earth, he contends, was all first made out in Great Britain, or on the continent of Europe; and the people of the United States are allowed little or no credit for anything in the way of Science or of Invention that has been accomplished in their midst. It is humiliating to notice that this foul aspersion has been tamely received and submissively acquiesced in even by our Men of Science.

To this serious and degrading charge, it may be replied: the human mind is as well endowed, and the mental faculties are as fully developed, in these United States as in any part of Europe, or of the World. Among these endowments of the mind are the two compound faculties of Reason and Invention; by means of the exercise of the former, Science is attained, and by that of the latter, means are adapted to the attainment of ends, and mechanical inventions are produced. These two mental faculties interact upon each other—the exercises of the reason suggesting to the mind new inventions, while the operations of mechanical inventions often suggest new propositions in Science or new exercises of reason. In the same mind the two faculties are seldom or never equally developed; and it is with nations in this respect as with individuals: a nation may be as remarkable for its inventions as for its scientific attainments. The exercise of the reason, perfect or imperfect, is, however, necessary to the success

of either—this exercise constantly occurring throughout human existence. The perfect mode of exercise we have fully explained, and the imperfect mode that we have said may be understood by the term *experience*, is the same process gone through with *unconsciously*. The results of experience serve to influence the actions of those possessing them, although they are not so clearly defined as to admit of being expressed in language; but when the processes of experience can be retraced, so that the results may be stated intelligibly, the propositions embracing these results become part and parcel of true science.

The intellectual treasures embraced, in *experience*, are of infinitely greater value to the Inventor, to the Artist, and to Professional men generally, as every one will admit, than are the results of false reasoning, or the so-called treasures of a false system of Science. The Steam-engine, the Telegraph, the Photograph, our Signal Service, Lucifer matches, &c., none of which have been properly explained, or their operation understood by European Scientists, have been invented not only without aid from, but in despite of their false system of Science. The attempt of Prof. Tyndall and other Scientists to deprive the inventors of such, of the credit of these great and highly useful inventions, and to award this credit to the discoverers of the principles or generalizations of European Science, is simply preposterous.

In the United States, inventions, founded on *experience*, have taken the lead of Science, and the latter may derive the greatest benefit and advancement from a careful study and tracing out of the conclusions of *experience*, when dictated by good sound common-sense. This is what has been attempted, with no little success, in the new system of American Science—the study of its laws and principles, and the amendment and improvement of which are earnestly commended to scientists of our own and of every other civilized community.